Meat Fats For Frying Potato Chips

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THE question "What is a potato chip?" was answered by Schuette and Zehnpfennig (1) by reporting the analysis of 9 commercial samples of chips. The composition varied as follows:

	Percent
Moisture	2.9- 4.7
Ether soluble	28.9-51.9
Starch	30.3-43.4
Reducing sugar	traces
Protein (NX 6.25)	5.5- 8.2
Ash	3.2- 5.8
N-free extract	7.1-16.5
Salt	1.2- 3.5

The role of fat in the frying of foods is essentially that of providing an efficient heat transfer medium which is especially adapted to transmitting heat rapidly and uniformly to the surface of the food. With reasonable care, it should permit control of temperature and time of frying so as not to dry the food excessively, nor to scorch or burn it, nor to leach its water soluble constituents. The fat may also contribute its own distinctive flavor and may promote or enhance the flavor and palatability of the other food constituents, as well as add to the nutritive value of the product.

Insofar as the physical characteristics involved in the frying, there would scarcely be any choice between vegetable oils, vegetable shortenings, animal fats, or blends of animal and vegetable fats. Therefore, the choice of a frying fat must be made on considerations of palatability, keeping quality, and appearance (eye-appeal) of the product as influenced by the fat.

There are, of course, a number of factors (2) that influence the quality of the chips, which are beyond the control of the shortening or oil producer. They are:

1. The variety and conditions of storage of the potatoes.
2. Type and care of frying equipment.
3. Selection of suitable package to lessen the effects of light and to decrease staling.
4. Rate of fat replenishment or turnover of fat in frying kettle.
5. Use of alkalies or chemicals in washing of raw potato slices.
6. Control of conditions for frying.

We will now consider factors that are within the control of the producer of shortenings and frying fats and that may influence the quality of the chip or fried product.

1. **Melting point or congeal point**— Fats and oils having widely different melting points may be used satisfactorily. In general, however, fats with melting points much above 45° C. (113° F.) may be undesirable because of the waxy "feel". The use of liquid frying fats, such as peanut oil, often add a desirable flavor to the chip, but suffer a disadvantage in stability or keeping quality when compared with hydrogenated shortening made from the same oil. In general, the higher melting fats are the more stable.

2. **The iodine number** is of help in the selection of a frying fat only to the extent that it gives some indication of the inherent stability. Fats with high iodine numbers generally contain substantial amounts of polyunsaturated components which are the most susceptible to rancidity.

3. **Free fatty acids** — The presence of free fatty acids in the frying fats, at least up to 1%, does not appear to be serious, because the moisture of the potato slices soon builds up a free fatty acid content of over 1% in the fats owing to hydrolysis. However, free fatty acids in the fresh starting fat much above 0.1% often is an indication of poor quality fat.

4. **Stability or resistance to rancidity** appears to be the most important criterion in the selection of a fat for frying chips particularly on a commercial basis. The determination of stability of the fat or oil by any of the common methods, such as the Active Oxygen Method, unfortunately, is not a reliable means of predicting the keeping quality of this fat when it is retained in the chip after the frying, particularly when antioxidants are added. Hence, it is much more informative to actually compare frying fats on the basis of stability (keeping quality) tests conducted on the chips —usually incubation tests at 100-145° F.

Considerable work has been published on the stability of fats for deep-fat frying. In general, without added antioxidants, hydrogenated vegetable oils (shortenings) are much more stable than vegetable oils, oleo oil, or lard. The more common vegetable oils, cottonseed, corn, peanut, and soybean oils, contain a relative abundance of natural antioxidants — tocopherols (0.05 — 0.1%). They also contain a high proportion of linoleic acid (as glyceride) which is extremely susceptible to atmospheric oxidation or rancidification. Hence, in these highly susceptible oils, the tocopherols are only moderately effective antioxidants. When the linoleic content of these oils is greatly reduced by hydrogenation to shortening consistency, however, the tocopherols present become much more effective in retarding oxidation of the resultant fat because there are fewer "active centers" remaining to be protected.

Owing to the relative abundance of tocopherols in vegetable oils and vegetable shortenings, simple admixture of them with fats that are essentially lacking in natural antioxidants, e.g. meat fats, imparts substantial protection to the mixture. It has been shown (3) that as little as 5-6% of vegetable oils or shortening added to lard increases the stability of the product 2-3 fold. Admixture with greater amounts of vegetable fats results in proportionately greater increases in stability. In fact, this type of blending has been proposed and is being used as a practical means of marketing meat fats in the classification of shortenings.

Magoffin and Bentz (4) investigated mixtures of vegetable fats and lard for use in frying potato chips. Their results may be summarized as follows:

Chips fried in mixtures of equal amounts of lard and peanut oil kept better than chips fried in either fat separately.

Chips fried in mixtures of equal amounts of vegetable shortening and lard kept nearly as well as those fried in vegetable shortening alone, and of course much better than those fried in lard alone.

Antioxidants — Kraybill and coworkers (5) have published comparative evaluations of a number of antioxidants for chip frying in lard. Their frying experiments were done on too small a scale for direct interpretation in terms of commercial operation but in a comparative sense their results indicated the more effective antioxidants. Polyphenols such as NDGA, hydroquinone, propyl and lauryl gal-

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TABLE I: Keeping Quality of Potato Chips Fried in Different Fats With and Without Added Antioxidants

Test[1] No.		Keeping Quality of Chips at 145° F. days
1	Lard (Control)	5
2	Lard + BHA	24
3	Lard + BHA combination	32
4	Peanut Oil (Control)	4
5	Peanut Oil + BHA	13
6	Peanut Oil + combination	14
7	Cottonseed Oil (Control)	4
8	Cottonseed Oil + BHA	6
9	Cottonseed Oil + BHA combination	14
10	Vegetable Shortening (Control)	25-30
11	Vegetable Shortening + BHA	47
12	Vegetable Shortening + BHA combination	58
13	Lard 50% + Peanut Oil 50% (Control)	14
14	Lard 50% + Peanut Oil 50% + BHA combination	18
15	Lard 50% + Vegetable Shortening 50% (Control)	30
16	Lard 50% + Vegetable Shortening 50% + BHA	47
17	Lard 50% + Vegetable Shortening 50% + BHA combination	47
18	Lard 40% + Vegetable Shortening 60% (Control)	42
19	Lard 40% + Vegetable Shortening 60% + BHA	61
20	Lard 40% + Vegetable Shortening 60% + BHA combination	70
21	Vegetable Shortening (Control)	44
22	Vegetable Shortening + BHA	65

[1] Test Nos. 1-17—laboratory-scale fryings
Test Nos. 18-22—commercial scale fryings

late added to lard in .01-.016% concentration increased the stability of the chips by the Schaal Test about 5-8 fold, whereas AMI-72* in 0.015-0.025% concentration increased the stability about 30 fold.

Magoffin and Bentz (4) also investigated the effect on chip stability of butylated hydroxy anisole (BHA) (.02%), and BHA (.02%) in combination with propyl gallate (0.006%) and citric acid (0.004%) in vegetable oils, vegetable shortenings, lard, and various blends of these fats and oils. Both laboratory and commercial scale frying operations were used. Some of their results are given in Table I.

It appears from results in Table I that potato chips of excellent keeping quality can be produced when lard is used for frying provided that suitable antioxidant is added, or when lard is blended with about equal amounts of vegetable shortening. The addition of antioxidant to these blends further increased the keeping quality of the chips.

* Combination of butylated hydroxy anisole, hydroquinone and citric acid.

The results published by Sair and Hall (6), however, indicate that the effectiveness of BHA in lard used for frying chips is largely lost after the fat has been heated for a few hours in the frying operation. Further work, therefore, is necessary to thoroughly assess the value of the antioxidant for this application. Wide differences in results might reasonably be expected under different conditions of frying since there are numerous variable factors that can influence the results —probably the most important one is the rate of replenishment of stabilized fat to the fryer.

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